DOCUMENT RESUME

ED 362 165 IR 016 321

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TITLE Multimedia: A Gateway to Higher-Order Thinking Skills.
PUB DATE Jan 93
NOTE 15p.; In: Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology Sponsored by the Research and Theory Division (15th, New Orleans, Louisiana, January 13-17, 1993); see IR 016 300.
PUB TYPE Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150) -- Computer Programs (101)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Civil War (United States); *Computer Assisted Instruction; Cooperative Learning; Databases; Higher Education; Historiography; *Instructional Design; Interactive Video; *Material Development; Modeling (Psychology); *Multimedia Instruction; Professional Development; *Social Studies; *Thinking Skills; Tutoring
IDENTIFIERS George Mason University VA; Historical Research; *Multimedia Materials; Prototypes

ABSTRACT

In June 1990, the research group at George Mason University (Virginia) Center for Interactive Educational Technology began designing a multimedia prototype to foster higher-order thinking skills in social studies. As an initial step, the Civil War Interactive Project using the Ken Burns documentary, "The Civil War," was used in a design demonstration. This computer-based instructional system will teach a systematic process for developing higher-order skills while learning how to engage in historical inquiry. Work on the generic instructional shell has identified the following elements to be addressed in the design of effective instructional multimedia products: (1) explicit instruction; (2) modeling; (3) tutoring/coaching; (4) student control through "custom tours" of the data and the production console; (5) cooperative learning; (6) equity of access to information; (7) quality of the database; and (8) professional development. Application of the multimedia shell in the Civil War Interactive Project is illustrated through the experiences of three students. The prototype products that the project will produce will help demonstrate how to harness the instructional power of emerging multimedia technologies. (Contains 54 references.) (SLD)

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Multimedia: A Gateway to Higher-Order Thinking Skills

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Multimedia: A Gateway to Higher-Order Thinking Skills

A Work In Progress

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BACKGROUND

The onset of the information age has made it imperative that learners develop higher-order thinking skills. Research is just beginning to reveal the full power of multimedia technologies to address this need as it focuses on the amalgamation of multimedia attributes rather than on the significance of any one characteristic. Multimedia technologies can contribute to the development of higher-order thinking skills because they facilitate: learning via structured discovery, student motivation, multiple learning styles, the navigation of web-like representations of knowledge, learner authoring of materials, the collection of rich evaluative information, and collaborative inquiry. The educational reform movement is providing momentum for change at the same time that multimedia devices are finally becoming affordable to schools. It is within the context of this evolving educational environment that we undertake the Multimedia and Thinking Skills Project in order to demonstrate a new paradigm for inquiry-based learning.

In June of 1990, the research group at George Mason University's Center for Interactive Educational Technology (CIET) began designing a multimedia prototype to foster higher-order thinking skills in the social studies. As an initial step toward that objective, The Civil War Interactive Project using Ken Burns' documentary, *The Civil War*, as the core of a multimedia database produced a design demonstration. This computer-based instructional system teaches a systematic process with which to develop higher-order thinking while learning how to engage in historical inquiry. With funding from the Corporation for Public Broadcasting and technical assistance from Apple Computer, the team took the first steps toward the ultimate goal of creating a generic instructional shell. This shell will be carefully conceived so that it empowers learners by giving them a tool that promotes the development of thinking skills as they acquire bodies of knowledge. We believe that this model of inquiry can be easily adapted to multimedia content across a range of disciplines, from science and mathematics to the social sciences and humanities.

As this initial project has progressed, four themes are providing a long-range focus for our work:

* The multimedia shell for teaching thinking skills is adaptable to material from a variety of disciplines.

* Design heuristic are emerging about how to design multimedia tools that give teachers leverage on the difficult issues of cognition, learning styles, motivation, cooperative learning, evaluation, and the unique needs of at-risk students.

* The quality of multimedia databases, particularly the quality of the video, is an important factor in creating effective multimedia prototypes that provoke higher-order thinking.

* Professional development activities that utilize innovative distance learning technologies such as on-line databases, teleconferences, and computer networks are central to successful utilization of multimedia products.

RATIONALE

In a world where the amount of data increases exponentially each year, a major challenge for schools is to prepare learners to access and use information effectively. Information management skills have never been more vital for students entering the work force. The computer has become an integral part of doing science and is quickly becoming a fact of everyday life. Computers generate vast amounts of technical data and the emerging information networks provide access to overwhelming amounts of information. However, learners frequently become lost in a morass of data and information and without higher-order thinking skills, they cannot synthesize large volumes of information into overarching knowledge structures. Unfortunately, rich technologies such as multimedia are often being used only to provide access to even more data in which learners can drown, thus exacerbating current problems rather than contributing to solutions.

We believe the same technologies that are swamping learners in data can help them master the thinking skills that will promote the synthesis of information. This requires a refocusing of current uses of multimedia in the curriculum, from engines for transmitting massive amounts of data to tools for structured inquiry based on higher-order thinking. Such an approach should be equally applicable to science, mathematics, the social sciences, and humanities. The best role for multimedia in schools is not to augment data delivery in conventional instruction, but instead to foster a new model of teaching/learning based on learners' navigation and creation of knowledge webs through a formal inquiry process. Dede (1990b) suggests that higher-order thinking skills for structured inquiry are best acquired where:

* Learners construct knowledge rather than passively ingest information;
* Learning is situated in real-world contexts rather than based in artificial environment like end-of-chapter textbook questions;
* Sophisticated information-gathering tools are used to stimulate learners to focus on testing hypotheses rather than on plotting data;
* Multiple representations for knowledge are used to help tailor content to suite individual learning styles;
* There is collaborative interaction with peers, similar to team-based approaches underlying today's science;
* Individualized instruction targets teacher intervention to assist each learner in solving current difficulties; and
* Evaluation systems measure complex, higher-order skills rather than simple recall of facts.

DESIGN ELEMENTS

This project has identified eight elements to be addressed in the design of effective instructional multimedia products: explicit instruction, modeling, tutoring/coaching, student control, collaborative learning, equity, the quality of the database, and professional development. The generic computer shell will have five generic features: the IBI (Inquiry Bureau of Investigation), Guided Tours, Dr. Know, the Production Console, and Custom Tours. The IBI is literally an iconic bureau; by opening each of its drawers, students receive explicit instruction on the steps of inquiry. Guided Tours model the inquiry process by taking student through the database on carefully designed paths that pose questions and compel them to evaluate the extent to which the data they encounter helps to answer these questions. Dr. Know is the context-sensitive coach or tutor who helps students develop data-gathering and metacognitive skills. Custom Tours is a non-structured access system to the data that allows free-form searches based on students' interests and are in the students' control. The Production Console gives students the tools with which to manipulate the information

in the database to make reports and create their own tours. It is not only a device for student control but it also facilitates collaborative learning. Other design element such as the quality of the database, equity, and professional development are discussed as environmental factors that must be considered if successful utilization of the shell is to be accomplished.

Explicit Instruction -- Inquiry Bureau of Investigation (IBI)

The IBI is literally an iconic bureau; by opening each of its drawers, students receive instruction in the steps of inquiry. Because higher-order thinking is neither instinctive nor developed as a result of teaching only content, providing opportunities in subject matter instruction for students to use thinking skills is not enough (Feuerstein, 1980; Perkins, 1987; Sternberg, 1984;). Instead, students need continuing, deliberate, and explicit instruction in how to use inquiry skills --- not in a decontextualized manner, but simultaneously with their striving to master subject matter (Salomon, 1991, Whimbey and Whimbey, 1975). Additional studies of database use in social studies (Ehman, Glenn, Johnson, and White, 1992; White, 1987) and hypertext use in science education (White, 1989) support the view that effective use of information by learners requires an array of thinking skill supports. In a study of word processing as a way to improve writing, Zellermayer, Salomon, Globerson & Givon (1991) indicate that courseware with guided instruction and continuous high-level cognitive help contributed to substantial improvement sustained over time and across technologies.

Modeling -- Guided Tours

Guided Tours model historic and scientific inquiry. They are purposeful environments that deliberately present contradictory observations, reports, or accounts that inspire students to invent additional questions, hypothesize answers, and identify potential sources of data. We have incorporated into our design an anthropomorphic coach, Dr. Know, who acts in Guided Tours to facilitate learners developing inquiry skills.

As Scardamalia, Bereiter, McLean, Swallow, Woodruff, (1989) describe, students require extensive scaffolding to sustain active, constructive approaches to learning. Their approach centers on procedural facilitation of learning --- not machine-based intelligence, but implicit structure and cognitive tools that enable learners to maximize their own intelligence and knowledge. In the context of multimedia, procedural facilitation requires the instructional system to present exemplary knowledge-structuring architectures, illustrative representational formats, and prompts that encourage expert information managing strategies. In our design, the Guided Tours provide the first two of these strategies for enhancing learning, and Dr. Know provides the third.

Tutoring/ Coaching --- Dr. Know

In our prototypes, resident scholar or context-sensitive coach, Dr. Know can be called upon to assist students in developing data gathering and metcognitive skills at each stop along the Tour. Laurel, Oren & Don (1990) describe a variety of ways that interface agents serving as guides can reduce the cognitive load for users of multimedia systems. In Guided Tours, Dr. Know gives context-sensitive advice on how to explore a cluster of data, how to think through issues in an inquiry situation, and what questions may be most productive to pursue. In the IBI, Dr. Know gives systematic instruction on the steps of inquiry within the context of the tour. As Beyer (1990) notes, instruction about thinking skills at the time that they are contextually needed to achieve subject matter mastery motivates students to acquire these skills and enhances the quality of subsequent learning. White (1987, 1989) also notes the importance of the interactive coach in supporting skill development.

In many ways, we are wrestling with the same issues as the Cognition and Technology Group at Vanderbilt (1990) who are examining the concepts of anchored instruction and situated cognition. They are creating instructional systems for various domains that permit students and teachers to experience inquiry through the actions of an expert. Our Dr. Know is an expert scientist or historian who takes learners (whom the Vanderbilt Group might describe as apprentices)

along on an investigation. Through modeling, Dr. Know helps learners develop their skills and knowledge. This investigative setting for anchoring instruction in an authentic context enhances learner motivation and makes the skills more likely to generalize into real-world environments.

For subject-independent material such as the IBI, Dr. Know's help transfers across disciplinary domains. For specific Tours in a particular subject, this context-sensitive help must be customized from generic templates by the instructional design team creating the multimedia materials for that domain. Dr. Know does not have generative capabilities, so is not an intelligent coach; the complexity of developing a discipline-independent, glass-box, knowledge-based system would exceed the benefits such a feature could provide. Because the inquiry model is generalizable across disciplines, our preliminary work indicates that small canonical variations of prompts make Dr. Know easily adaptable to a wide range of subject domains. Unlike the group at Vanderbilt, we have also incorporated explicit as well implicit instruction in inquiry.

Student Control -- Custom Tours

The environment we are developing supports instruction in which students have some freedom of choice --- including producing their own reflective multimedia materials as an outcome measure indicating mastery --- and in which they work in small groups using collaborative inquiry to explore and master multimedia material. In Custom Tours students can use the facilities of the Production Console (described below) to create their own path through the data.
Once students feel they know the inquiry process, they are encouraged to design their own Custom Tours. As students take more responsibility for their own learning, Dr. Know prompts them to state Thoughtful Questions and hypotheses that will help them establish what Scardamalia et al. (1989) term goal orientation. A major objective of the goal orientation strategies Dr. Know conveys is to de-emphasize the tendency of naive learners (and teachers) to rehearse or memorize information; instead, stress is placed on skills that allow data to be reconfigured as needed.

Helgeson (1987) establishes the importance of student freedom, choice, and the use of small groups as effective in improving scientific problem-solving behaviors. However, while freedom for students to navigate and explore knowledge webs is important, our prototypes will also provide extensive implicit structure via Guided Tours through the multimedia database. As Rivers and Vockell (1987) indicate in their study of computerized simulations and problem solving skills, students using guided versions of simulations surpassed those using unguided versions on tests measuring cognitive processes and critical thinking.

Student Control -- The Production Console

Beyond the cluster of capabilities associated with Dr. Know and the IBI, the multimedia/thinking skills shell enables learners to produce their own multimedia presentation and Custom Tours. The Production Console is a tool to help students construct both Custom Tours built around their own Thoughtful Questions and Reports that document their proof/disproof of the hypothesis from a Guided Tour. In the Production Console, students take data in various forms --- video, audio, graphic, animation, text --- that they have gathered in their Journal and manipulate them. Learners can add additional data external to the prototype, can analyze their journal entries based on the inquiry process in the IBI, and can author their own tours to augment those provided with the instructional system.

As Donoho (1986) notes, participation in audiovisual production contributes to student learning in curriculum areas such as language arts, social studies, and science. Students engaged in these production activities demonstrated improvements in self-concept, motivation, creativity, and attitude. In addition, these students increased their involvement with print media.

The Production Console is important for another reason: students use this feature to demonstrate their knowledge, their ability to analyze data and state conclusions, and their skills in applying what they have learned. To date, little work has been done on evaluating student outcomes from instruction with multimedia but a US Office of Technology

Assessment report (1987) indicates that, if technologies are to succeed in schools, teachers must have better methods of evaluating student outcomes. An objective of our project is to develop improved evaluative measures that can help teachers assess learners' mastery of inquiry skills.

Cooperative Learning

Capabilities such as the Production Console support cooperative learning because students can easily share and display data, comment on drafts, and keep collective records of their inquiry process. The production of multimedia tours is a particularly powerful vehicle for collaboration because learners must pool unique individual strengths (editing video, scanning images, digitalizing sound, creating animation, writing text) to develop a successful product. While there has been limited research on collaborative or cooperative learning in multimedia environments, Adams, Carlson, Hamm's (1990) review of the research indicates that collaborative learning with interactive technologies leads to higher scores on measures of content knowledge and observation skills, as well as high degrees of learner motivation and satisfaction.

Equity

Equity issues are an important theme underlying our approach to moving beyond traditional evaluation methods into innovative strategies that assess higher-order thinking skills and complex behaviors denoting mastery. Research suggests that current uses of information technology in education may be widening the gaps between rich and less affluent schools and between high-achieving and at-risk students (Ascher, 1984; McPhail 1985; Morgan, 1987). Public schools in impoverished districts and small rural schools are more likely to have high student/computer ratios, and wealthy schools tend to offer computer-based enrichment activities while financially stressed schools focus on computer-assisted remediation. Educational policy goals are clear in mandating that instructional technologies be made equally available to all students and in supporting efforts to address the needs of historically underrepresented populations.

In a recent summary of research on computers and at-risk students, Rockman (1991) notes that well-designed educational technology both enhances the achievement of at-risk learners and improves their attitudes toward school and the subject matter they study. Even though many of these studies warn of novelty effects on achievement and attitude outcomes, the research seems to indicate that at-risk students, using information technology, experience gains in linguistic fluency, subject matter comprehension, problem solving abilities, and mathematics skills. Attitudinal measures demonstrate higher levels of self-confidence and self-esteem, enthusiasm for the use of technology, and appreciation of the ability to control the pace of their learning (Clariana and Smith, 1988; David, 1986; Diessner, Rousculp, & Walker 1985; Edeburn and Jacobi, 1985; Ely, 1984; Henderson, Landesman, & Kachuch, 1983; Jacobi, 1985; Laboratory of Comparative Human Cognition, 1989; Mehan, Moll, & Riel 1985; Miura, 1987; Payne, 1986; Rosegrant, 1985; and Ross, Smith, Morrison, Ericson, & Kitabchi, 1989).

However, little research has been done that documents how multimedia technology can be designed to effectively build on the strengths and motivations of at-risk students. We believe that our multimedia/thinking skills approach offers promise for motivating students who find conventional instructional materials uninteresting because they are predominantly textual/symbolic, passive, linear, centered on memorizing data, and remote from issues learners find meaningful in their own lives. In particular, we hypothesize that multiple representations of knowledge to address different learning styles, collaborative inquiry to build on differential individual strengths, and active production of knowledge webs could reach students now uninvolved in classroom instruction.

Quality of the Database

As Kozma (1991) notes, the instructional effectiveness of any one medium varies with the nature of instruction and the nature of the learner. We are concerned with constructing a multimedia database that stimulates thinking and supports a variety of diverse learners as they construct their own cognitive webs. We draw from a very high quality

video database for The Civil War Interactive Project, Ken Burns' film *The Civil War*, and augment it with a rich collection of primary source documents including photographs, diaries, audio tapes and maps. During the development of the project we will attend to the extent to which the nature and quality of the database affects learning for a wide array of learners.

Particular attention will be paid to the role of video. Research into the instructional effectiveness of video alone has not produced clear results, as Johstone (1987) notes, film and video are more works of art than feats of engineering thus making it difficult to quantify the qualities of film and video that make it affective in instruction. However, we do know that well-produced video helps to motivate students; Gibbon & Hooper (1986) found that video was a powerful force in motivating students to want to learn more science and mathematics.

In some previous educational multimedia products there has been a tendency to utilize "repurposed " video segments (segments originally intended for a completely different use) or to use segments of lower quality. Semper (1990) argued that the quality of the video segments employed in multimedia products affects the level of learning attained by users and that higher quality segments encourage greater involvement and thus more learning. Naimark (1990), Chen (1990), and Ambron (1990) agreed, with each citing the relationship between the quality of the video and the quality of the learning experience. Mountford (1990) accounted for this relationship by suggesting that "drama has the power to engage audience members both emotionally and intellectually" (p.21), while Florin observed that "because the footage is emotionally compelling, you want to learn more on the subject. . . . But what is most significant here is that the story gives you a reason to study the materials" (1990, pp. 36-37). In light of these concerns, our project draws upon powerful and informative footage with high production values, seeking to use powerful video segments as vehicles for learner involvement. The demonstration prototype of the Civil War Interactive Project utilized the powefull footage from Ken Burns' series, *The Civil War*, to draw students into the adventure of historical inquiry. Similarly, the other prototypes in the Multimedia and Thinking Skills Project will utilize well-produced footage that will draw learners into the study of science, mathematics or social sciences. We view video producers and others with extensive video experience as key members of our development team.

Professional Development

Excellent curricula that rely on non-traditional models of teaching/learning tend to fail unless support is provided for teachers to master the new paradigm for instruction (Havelock, 1970, 1973). As the prototypes are developed, we will assess the types of scaffolding necessary for teachers to use these materials successfully in a typical classroom without special resources or expertise. The professional development methods we envision include both conventional strategies (workshops, self-instructional kits) and innovative, telecommunications-based approaches such as videoconferences and networked virtual communities for providing support across barriers of distance.

The central focus underlying all these professional development efforts is to help teachers reconceptualize the purpose of disciplinary instruction: from memorization of facts to mastery of thinking skills and knowledge. Even with a sophisticated multimedia prototype to scaffold their instruction, teachers need extensive support to restructure their pedagogical approaches toward inquiry-oriented learning. In a study of teachers' critical thinking and performance in social studies, Fontana (1980) noted that success in improving students' critical thinking skills may depend on improving teachers' skills in integrating higher cognitive activities into their instructional planning and implementation.

One product of this project will be a plan that both details the scope and type of professional development needed to enable teachers to use our multimedia/thinking skills materials and assesses opportunities to use emerging information infrastructures to support ongoing instructional innovation. Dwyer, Ringstaff, & Sandholtz (1991) note that effectively integrating technology into the classroom requires changes in teachers' instructional behaviors. Over time, these behavioral changes occur as teachers reflect on their own beliefs about learning and instruction and as the administrative structure of the school shifts to accommodate these changes. These researchers also note that the nature of the support needed for teachers as they engage in the process of change alters at different stages of implementation.

For example, in early stages of innovation teachers' needs center on their concerns about the technology itself; skill development is the most important type of support. As adoption and adaptation proceed, teachers increasingly need opportunities to think about instructional issues and to engage in ongoing dialogues about their experiences.

Hunter (1990) points to the potential of computer-mediated communications to support teachers as they experience fundamental change in their instructional strategies and beliefs. Fontana and Ochoa (1985) caution that administrators need to provide supportive environments for change and require their own training and support system. Bruder (1991) outlines some of the current local and regional activities that use telecommunications to train teachers. Dede (1990a) describes trends that are making distance learning via telecommunications a reality in professional development. All this research underscores the need for the development of creative technology-based strategies for professional development.

The Thinking Skills Project views students as tourists through multimedia databases. Just as tourists make choices about how they will explore different sights, users of our multimedia/thinking skills shell can decide how to explore their cognitive environment. They may choose one of several Guided Tours or they can explore the database via Custom Tours. A reflective context for learning is created in the exemplary Guided Tours; these provide stimulating environments within which students become actively engaged in learning the subject domain while receiving context-sensitive instruction on the inquiry process. As students proceed through Guided or Custom Tours, they are able to call up their on-line tutor, Dr. Know, to help them evaluate information in various form. During their tours they collect information in their electronic Journal which they take to the Production Console. It is here in the Production Console where they consult the IBI and make certain they have followed all the steps; they are then ready to create reports or design their own tours.

Because it is so difficult to envision how the feature we have just discussed will work together to promote the development of higher-order thinking, we have included a short scenario that describes one way in which The Civil War Interactive Multimedia Product might be used in the classroom. This is just one of many optimistic visions of the potential classroom application of our work.

THE APPLICATION OF THE MULTIMEDIA SHELL: THE CIVIL WAR INTERACTIVE

Ron, Juan, and Kim are three students from Ms. Regis's class who have chosen to develop a cooperative inquiry project on the Civil War. Ms. Regis has suggested some potential topics the students might select and has encouraged them to pursue other topics once they can frame these in the form of Thoughtful Questions. The students were present when Ms. Regis briefed the class on using The Civil War Interactive; while Juan and Kim are excited and interested, Ron is not sure he wants to do much work. He really doesn't see how the Civil War relates to him and is not so sure about this new technology. While Juan and Kim are interested in the topic they are not entirely comfortable with the inquiry process or how to operate the instructional system.

Juan takes the lead with the mouse and enters the system hesitantly. On the opening screen, he identifies himself as a group leader for the "Yankees" and starts by reviewing the Guided Tour that Ms. Regis used in her class discussion. They choose the Tour which is guided by the Thoughtful Question "How are peoples lives affected by war?". They open the Guide book and see the four stops: Prewar Life in the South, Prewar Life in the North, The Portrait Gallery, and Life After the War. They decide to go further. Ron grumbles, "this is boring." He would rather do something else; after all, what does the Civil War have to do with him? He only half listens as Juan and Kim discuss the kinds of answers they might expect to find in response to the Thoughtful question.

He finally speaks up when Juan and Kim are trying to decide whether to go on this tour. Ron thinks that they should. At the next screen the group sees two hypotheses. The instructions on the screen indicate that they must choose one. Ron is not even sure what an hypothesis is, or why he should care. But as he looks at the second one, his interest is peaked and he encourages the students to choose the hypothesis that states:

Individuals in the North and South were affected differently by the Civil War depending on their economic, political, social, and geographic circumstances.

They then decide to go to the first stop, Prewar Life in the South. They are unsure which of the sights to visit. Mrs. Regis comes over to see if they are having trouble and they tell her they are not certain what to look at first. She suggests that they might want to check with Dr. Know. By clicking on the icon at the bottom of the screen, a second screen pops up and lists three kinds of advice you can get: "E" or exploration advice, "T" or thinking process advice, or "Q" for more questions to consider. Ron wants to check the exploration advice. Juan says OK and turns the mouse over to him. He clicks and a screen then pops up that explains the relationship between the information found at the different sights and suggests that they begin with the Agriculture and Plantation System.

Kim is interested in the kind of thinking advice they will receive and asks Ron to go back to Dr. Know to get that advice. Here they get some suggestions about how they should be thinking about this information in relationship to their hypothesis. Back at the first screen of the first stop they take Dr. Know's advice and go to the plantation system. Another screen comes up with classifications of primary sources they can examine on Slaves, Plantations, Social Life, and Political Life. They choose to look at more information on slavery and find that they can explore documents, video shows, or photographs. Kim wants to see the comprehensive video essay. She remembers that Mrs. Regis showed some of it in class and she wants to see it again. The video monitor pulls up the footage from *The Civil War*; the music is Jacob's Ladder and then they hear the crickets as the camera explores the photographs of slaves working in the field. Then the narrator begins to speak as the camera focuses intently on the photographs of individual slaves on the auction block and slaves in chains.

Ron is now rivetted. He was not in class the day Ms. Regis gave the introduction. He had no idea how horrible slavery was. He had never been this close to it before. Kim comments that slavery is no longer just a word in a book. It was a horrible way to live. Ron is listening to the narrator give the statistic on the number of African Americans who lived as slaves and what life was like in a slave cabin. He can't take it all in. He stops the video and goes back and calls up the section on slave cabins again and hears and sees one more time how awful the ordeal really was.

They are about to go into more depth on the issue of slavery by examining the pension record of an African American woman, Susan Drane, when a prompt reminds them that they are on a Guided Tour and they might want to review where they have come so far and perhaps note other questions they have on this topic in their Journal for latter consideration.

The students agree, but they have forgotten the hypothesis. They think a minute and Kim realizes that all they need to do is to click on hypothesis at the top of the screen. Up it pops. She now wants her turn on the mouse. She clicks, up pops the Thoughtful Questions. Now they are not at all sure what to do. Juan suggests that they ask Dr. Know who, in turn, suggests that they review the pension record carefully looking for information on how the war affected African Americans in the South, and that they place that in their Journal. He notes that if they go to the Journal it will give them directions about how to capture video footage, copy text from the document, and how to write their own notes. They take the advice and work on composing their joint observations.

They return to the pension record and because it is 13 pages long, they decide to print it out and Kim agrees to read at home and mark the sections that they should keep in their Journal. She is really interested in how African American women lived under slavery and during Reconstruction. She thinks about the fact that her ancestors must have lived like this.

The students continue their Guided Tour over the next two days. They explore the video segments on African American troops, they meet John Boston and make a copy of his letter. They read part of Mary Chestnut's diary and then hear how she used the diary to help her cope with the war. They hear the words of U.S. Grant, W.T. Sherman, and Robert E. Lee and are struck by the fact that their letters home sound much like any other soldier who wants a

war to end and to come home to those who love them. They also hear and read the words of Abraham Lincoln and come to know the pain of a man who is trying to hold his country together; yet not compromise an important principle like freedom. They learn how many of the founding fathers like Thomas Jefferson were just as tormented by slavery as Lincoln, while others felt that the issue of states rights was more important.

They have kept good records in their Journal and now have much to sort out. They move the Journal to the Production Console. Now what? They click on the Dr. Know and he suggests that they review the steps of inquiry by clicking on the drawers of the IBI (Inquiry Bureau of Investigation). They skip the Question and Hypothesis drawer and go directly to the drawer marked Testing Data.

They review the data they have gathered and then double-check their Journal taking note of the patterns. They then begin to apply the questions in the Testing Data drawer and discuss their immediate project.

> Is your data relevant or necessary to proving or disproving the hypothesis?
> Do you have sufficient data?
> What is the source of each piece of data? Is the source credible? Is it reliable?
> Does any piece of data incorporate bias or narrow points of view?
> Does each piece of data make a persuasive and logical argument?
> Are stereotypes represented?

The students are not familiar with the full meaning of each of the elements of the Data Test. However, by clicking on any step, they receive a brief description of that stage of the inquiry process and illustrative examples of how to apply that type of data test. The students complete the second day of their cooperative inquiry by eliminating some of the evidence they collected and by beginning to arrange the remainder in a form that addresses their hypothesis.

Ron and Kim have found some other charts and data in books in the library; they scan these into their Journal. The students now feel that they have enough data to begin writing their conclusions. They refer occasionally to the Concluding drawer, which helps them state their conclusions based on the data they have gathered. The group eventually comes to agreement with regard to whether they have proven their hypothesis true or false. They begin to compose their multimedia report.

They realize in the middle of the process that history and multimedia are more fun than they expected, especially since each member of the group can build on his/her strengths: Ron is the technical expert, Juan the visual editor, Kim the writer. In the process of using the Production Console to prepare the presentation, they realize how much they have learned. They discuss the fact that they had never thought about what life was really like under slavery. Ron is particularly amazed because he never liked history. Kim wants to find out more about African American Women and Juan enjoys sorting through the information and carefully selecting what will become part of their presentations. They all feel more confident about starting their next research project in history. They all feel that they have a deeper sense of what the Civil War was about.

They are anxious to show their work to Ms. Regis, who is very impressed with what they have done. She reviews the students' inquiry process and conclusions and then has them go through the inquiry check-list that is part of the evaluation strategy for student products. She then is ready to review their presentation and listen to their analysis.

(This scenario was adapted from The Civil War Interactive Demonstration and Project Design Document)

CONCLUSION

The Multimedia and Thinking Skills project described here is an ambitious one. It combines the development of an instructional multimedia products with the search for new knowledge about the potential of the technology. While looking to past research to inform design decisions, the project is not bound by existing models. The prototype products that we hope to produce will be more than rich multimedia databases with sophisticated navigational systems

but will provide a glimpse into the future and help us all understand more clearly how to harness the instructional power of the emerging multimedia technologies.

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